SPECIFICATION

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METHODS AND SYSTEM FOR COOLING DEVICE CONTROL

Background of Invention

[0001] This invention relates generally to cooling devices and, more particularly, to controlling and monitoring cooling devices.

[0002] At least some known cooling devices include a compressor to compress a refrigerant and an evaporator to evaporate the refrigerant. During an evaporation process, a temperature of the refrigerant lowers and absorbs heat providing a cooling of a main compartment of the cooling device. The evaporated refrigerant is compressed by the compressor and then condensed into a liquid state by a condenser. Several processes may cause ice to accumulate within the cooling device. Over time, ice accumulation may lower a cooling efficiency of the cooling device. Therefore, the cooling devices are occasionally defrosted to remove accumulated ice to prevent a failure of the cooling device which may cause spoilage of contents stored within the cooling device.

[0003] To facilitate preventing a cooling device failure, some known cooling devices are controlled and/or monitored. One known control technique employs an electronic thermostat such as a model TC-110 electronic thermostat commercially available from Elstat Electronics LTD, Lancashire, England. The thermostat is coupled to the cooling device to provide temperature control of the coupled cooling device at that particular cooling device's location. Therefore, a plurality of cooling devices at different locations are not controllable from one location using a known thermostat.

Summary of Invention

[0004] In one aspect, a method for assembling a control for use with a cooling device

includes providing an attached control that is configured to control the cooling device, and installing a wireless interface in the attached control.

[0005] In another aspect, a method for controlling a cooling device includes providing a cooling device and providing a control device in wireless communication with the cooling device and configured to control the cooling device.

[0006] In another aspect, a method for controlling a plurality of cooling devices includes installing a wireless interface in each cooling device and controlling the cooling devices with a wireless control device.

[0007] In a further aspect, a method for assembling a cooling device includes providing a wireless interface and installing the wireless interface in a cooling device such that the cooling device is controllable via wireless communication.

[0008] In one aspect, a method for controlling a cooling device including a wireless interface is provided. The method includes providing a wireless control device and inputting into the wireless control device at least one parameter for the cooling device.

[0009] In another aspect, a system for controlling a cooling device is provided. The system includes an attached control and a wireless interface operationally coupled to the attached control.

[0010] In another aspect, a system for cooling product includes a cooling device and a control device in wireless communication with the cooling device.

[0011] In a further aspect, a cooling system includes a plurality of cooling devices each including a wireless interface, and a control device in wireless communication with each of the cooling devices.

[0012] In another aspect, a computer is configured to wirelessly communicate with a cooling device and receive from a user at least one parameter for the cooling device.

Brief Description of Drawings

[0013] Figure 1 is a perspective view of a cooling device.

[0014] Figure 2 is a perspective view of one embodiment of an attached control.

[0015] Figure 3 is a schematic of a control system including a control device and a plurality of the cooling devices shown in Figure 1.

[0016] Figure 4 is an exemplary embodiment of a device selection interface that the computer shown in Figure 3 displays on a monitor.

[0017] Figure 5 is a user interface displayed when a user selects a specific listing shown in Figure 4.

[0018] Figure 6 is an alarm history that is displayed when the user selects the alarm history tab shown in Figure 5.

Detailed Description

[0019] Figure 1 is a perspective view of a cooling device 10 including an attached control (not shown in Figure 1). In one embodiment, cooling device 10 is an Gamko Model GR 038600RS420 cooling device commercially available from Gamko Holding, AL Etten Leur, Holland. In another embodiment, cooling device is a model GR-05013XSS420 stand alone cooling cabinet commercially also available from Gamko Holding, AL Etten Leur, Holland. In another embodiment, cooling device 10 is a commercial bottle cooling cabinet such as a Gamko Maxiglass cabinet model numbers MXB-20/150 and 20/250 commercially available from Gamko Holding, AL Etten-Leur, Holland. In a further embodiment, cooling device 10 is a commercial freezer such as a Gamko GF-100600RS420 and/or a GF-12513XSS420 commercial freezers also commercially available from Gamko Holding, AL Etten-Leur, Holland. Alternatively, cooling device 10 is a residential refrigerator or refrigerator/freezer such as a GE Profile Arctic Top Freezer/Refrigerator model number PTS22LBMWW commercially available from the General Electric Company, General Electric Appliances, Louisville, Kentucky. In an exemplary embodiment, cooling device 10 includes a known compressor (not shown), a known condenser (not shown), and a known evaporator (not shown). Cooling device 10 utilizes a refrigerant (not shown) to cool a main storage compartment 12 for storing cooled or frozen products. In one embodiment, the refrigerant is either Ammonia or Freon. In another embodiment, the refrigerant is neither Ammonia nor Freon. Cooling devices include, but are not limited to, chillers, ice builders or ice

makers, refrigerated cabinets, cold storage cells, and other refrigerant type cooling units including units utilizing all refrigerants. Therefore, as used herein, "cooling device" refers to refrigerant type cooling units including industrial units and residential units which have a compartment for storing cooled or frozen products, including ice made by the cooling unit.

[0020] Figure 2 is a perspective view of one embodiment of an attached control 20 including a program switch/reset button 22 and a display area 24 including a temperature indicator lens 26 and a defrost indicator light 28. Attached control 20 also includes a Temperature set button (lower)/Manual defrost button 30, and a Temperature set button (higher) Display on/off button 32. Attached control 20 also includes a first calibration sensor (not shown), a second calibration sensor (not shown), and a wireless interface (not shown) such that control 20 is in wireless communication with a control device (not shown in Figure 2). In one embodiment, attached control 20 includes a satellite interface (not shown) and is in wireless communication with the control device via the satellite interface. In another embodiment, attached control 20 includes an infrared interface (not shown) according to IrDA (The Infrared Data Association) level 0 standard (one meter). In a further embodiment, attached control 20 includes a radio frequency (RF) interface (not shown) and is in wireless communication with the control device via the RF interface at approximately 433.9 MHz. In one embodiment, attached control 20 includes a wireless interface coupled to a commercially available TC-110 electronic thermostat.

[0021] During operation of cooling device 10 (shown in Figure 1) including attached control 20, a control device permits wireless control of cooling device 10. More specifically, a user can specify an upper and lower setpoint for cooling device 10, wherein the upper setpoint refers to a temperature at which attached control 20 directs cooling device 10 to activate a cooling system (not shown) of cooling device 10, and the lower setpoint refers to a temperature at which attached control 20 directs cooling device 10 to de-activate operation of the cooling system. Alternatively, the user specifies a setpoint and a differential or temperature range about the specified setpoint. In a further embodiment, cooling device 10 is a heating device and the user specifies a negative differential. For example, cooling device 10 is programmed to heat main compartment 12 to 100 ° C with a negative differential of

10 ° C and when main compartment 12 reaches 90 ° C, (programmed temperature minus negative differential) then cooling device 10 re-heats main compartment 12 to 100 ° C. The user can also specify a plurality of defrost parameters including a defrost interval, a defrost duration, and a defrost method. The defrost interval refers to a length of time that elapse between consecutive defrost cycles. The defrost duration refers to a length of time that the defrost cycle will run. The defrost method can be off-cycle, heating element, or hot refrigerant.

[0022] The defrost parameters also include a maximum allowable appliance temperature during defrost, and a maximum allowable evaporator temperature during defrost. The appliance temperature refers to the temperature inside main storage compartment 12. Additionally, as used herein, unless otherwise stated, all temperatures refer to a temperature inside main storage compartment 12. For example, the upper and lower setpoint temperatures refer to the temperature of main storage compartment 12. The evaporator temperature refers to the temperature of the evaporator. If either maximum allowable temperature is reached during a defrost cycle then the defrost cycle is ended regardless of the specified defrost duration. Otherwise, if neither maximum allowable temperature is reached, then the defrost cycle continues until the specified defrost duration is complete.

[0023] The defrost parameters also include a fan stop choice during defrost indication that enables a user to specify whether a fan is on or off during a defrost cycle. Alternatively, the user can specify a fan delay such that the fan is on during a portion of a defrost cycle. The defrost parameters also include a message on display during defrost. The user can specify that the temperature of cooling device 10 before a defrost cycle is started is displayed during the defrost cycle. Alternatively, the actual temperature of cooling device 10 during a defrost cycle is displayed. The user can also specify that the letters DEF are displayed during a defrost cycle. Additionally, the user utilizes the control device to specify whether or not cooling device 10 can be manually defrosted. When the user specifies that cooling device 10 can be manually defrosted, then attached control 20 can be used to manually defrost cooling device 10. When the user specifies that cooling device can not be manually defrosted, then attached control 20 can not be used to manually defrost cooling device 10.

[0024] The user also utilizes the control device and attached control 20 to specify a plurality of alarm parameters including an alarm delay parameter and an alarm buzzer enablement parameter. The alarm delay parameter represents an amount of time that elapses before an alarm is signaled after detecting an alarm condition. The alarm buzzer enablement parameter allows the user to specify whether a buzzer (not shown) of attached control 20 will sound during an alarm condition. Regardless of the status of the alarm buzzer enablement parameter, attached control 20 always communicates an alarm to the control device.

[0025] The alarm parameters also include an alarm interval parameter and an alarm duration parameter. The user utilizes the alarm interval parameter to specify a minimum time period between alarms. The alarm duration parameter allows the user to specify a desired alarm duration. For example, the user enables the alarm buzzer and specifies an alarm duration of thirty seconds and an alarm interval of five minutes. When an alarm condition occurs, the buzzer sounds for thirty seconds and will not sound again until after the five minute time period elapses regardless of whether or not the alarm condition persists. If the alarm condition still persists after the alarm interval period has elapsed, then the buzzer will sound again for the specified alarm period. Typical alarm conditions include a low temperature alarm, a high temperature alarm, and a blocked condenser alarm.

[0026] Additionally, the user can specify via the control device whether the compressor operates during an alarm condition. The user also specifies a minimum compressor rest time, and whenever the compressor turns off, the compressor will not cycle back on until after the specified time elapses. Attached control 20 is configured to allow the user to specify via the control device a display stability, a display speed, and whether display 22 is on or not. The display speed refers to a length of time that a temperature is displayed before a different temperature is displayed. The display speed refers to increasing and decreasing temperatures. The display stability refers to a length of time that a temperature is displayed before a higher temperature is displayed. For example, in one embodiment, main storage compartment 12 is accessible by a door (not shown), and when the door is opened, the temperature inside main storage compartment 12 rises quickly, and when the door is then closed, the temperature then lowers quickly. The display stability allows for a distinction

between a sharp temporary temperature rise due to an open door versus an extended temperature rise. Furthermore, the user can specify the time zone that cooling device 10 is located in, and whether to display temperatures in Fahrenheit or Celsius. The user can also select a data interval in either minutes or hours. The data interval refers to how often attached control 20 transmits data including current status to the control unit. Attached control 20 is connected to a condenser sensor (not shown) and an evaporator sensor (not shown).

[0027] Attached control 20 can perform a failure a failure analysis based upon any alarm conditions and feedback from the condenser and evaporator sensors, as well as a temperature sensor in main storage compartment 12. In an exemplary embodiment, the sensors are negative temperature coefficient (NTC) sensors. The user also utilizes the control device to specify a brightness level for display 22. Display 22 is configured to display an indication that cooling device 10 is currently being defrosted. Display 22 is also configured to display indications of a refrigeration system failure, a high temperature alarm, a low temperature alarm, and an electrical fault condition or short.

[0028] Display 22 is also configured to display indications of sensor failures including a main compartment sensor failure, an evaporator sensor failure, and a condenser sensor failure. Attached control 20 also includes a memory that stores an average temperature, a lowest registered temperature, a highest registered temperature, and the number of door cycles in time zone. Attached control 20 is programmable such that time zones for data collection can be specified by the user. For example, a user programs a twenty-four hour time zone for a cooling unit including a door (not shown), and attached controller 20 counts the number of times that the door is opened within the twenty-four hour time zone. After each time zone, the count is reset to zero. The memory also stores the number of times the compressor has cycled on and a cumulative number of compressor operating hours. Display 22 is configured to display the average temperature, the highest registered temperature, the lowest registered temperature, the number of door cycles, the number of compressor cycles, and the cumulative compressor operating hours.

[0029] Figure 3 is a schematic of a control system 50 including a control device 52 and a plurality of cooling devices 10 (also shown in Figure 1) in wireless communication with

device control 52. In an exemplary embodiment, control device 50 is a computer and is hereinafter referred to as computer 50. In one embodiment computer 50 includes an internal database 54. In an alternative embodiment, computer 50 is coupled to an external database 56. As used herein, the term computer is not limited to just those integrated circuits referred to in the art as computers, but broadly refers to computers, processors, microcontrollers, microcomputers, application specific integrated circuits, programmable logic controllers (PLCs), and other programmable circuits. Computer 50 is connected to a known monitor (not shown) that displays visual outputs as explained below. Computer 50 includes a memory (not shown) configured to store data regarding cooling device 10. Specifically, the memory contains data regarding an alarm history for the cooling device, at least one defrost specification for the cooling device, data regarding at least one of an evaporator, a condenser, a compressor, and a fan. The memory also contains a service history for the cooling device, and data regarding historical status of the cooling device and current status of the cooling device. In one embodiment, the data is stored in one of database 54 and database 56.

[0030] Figure 4 is an exemplary embodiment of a device selection interface 70 that computer 50 (shown in Figure 3) displays on the monitor. Device selection 70 includes an asset owner tab 72 and an asset type tab 74. Device selection interface 70 also includes a plurality of device listings 76 displayed in a tree structure 78. A user navigates tree structure 78 and highlights a specific listing 76. Each listing 76 corresponds to an asset (cooling device). When asset type tab 74 is in the forefront of interface 70 (i.e., has been selected), data identifying an asset type and a graphic image 80 of the asset is displayed. When asset owner tab 72 is in the forefront (i.e., has been selected), then data identifying an owner of the asset is displayed. The asset owner data is stored in an asset owner database within at least one of database 54 and database 56. The asset type data is stored in an asset type database within at least one of database 54 and database 56. Data regarding an asset other than asset type and asset owner is stored in an asset database within at least one of database 54 and database 56.

[0031] Figure 5 is a user interface 90 displayed when a user selects a specific listing 76 (shown in Figure 4) representing a particular cooling device such as cooling device 10

(shown in Figure 1). User interface 90 includes an asset owner tab 92 and an asset type tab 94 that are used by the user as explained above regarding asset owner tab 72 and asset type tab 74 (shown in Figure 4). User interface 90 also includes an asset details tab 96. Selecting asset details tab 96 causes user interface 90 to display a general tab 98, a technical specification tab 100, a parameters tab 102, and a process data tab 104.

[0032] User interface 90 also displays a service history tab 106, an alarm history tab 108, a location tab 110, a graphic/picture tab 112, and a supply tab 114. Selecting process data tab 102 causes user interface 90 to display a plurality of data regarding the selected cooling device including an actual temperature, an evaporator temperature, a condenser temperature, a compressor status, a fan status, and the times that the temperatures and statuses were recorded. The actual temperature refers to the temperature of a main storage compartment of a cooling device.

[0033] Also displayed are a current temperature (5.3 °) and an average temperature (7.7 °). A minimum temperature and a maximum temperature are also displayed. Selecting general tab 98 causes user interface 90 to display general data regarding the selected cooling device. Selecting location tab causes user interface 90 to display the location of the asset. Selecting alarm history tab 106 causes user interface 90 to display an alarm history (not shown in Figure 5) of the asset. The alarm history is generated automatically when control device 52 wirelessly receives alarms from attached control 20.

[0034] Selecting service history causes user interface 90 to display a service history of the asset. The service history is provided by user input rather than through wireless communication with attached control 20. Selecting technical specification tab 100 causes user interface 90 to display data regarding technical specifications of the asset. Selecting parameters tab 102 causes user interface 90 to display a plurality of parameters including alarm parameters and defrost parameters as explained above. The displayed parameters include all user choices explained above including compressor parameters (compressor rest time and compressor on during alarm) and display parameters (display stability, display speed, display on or off, Fahrenheit or Calcius, display brightness).

[0035] The displayed parameters further include the specified time zone and the specified data interval. The user can change any parameter and control device 52 wirelessly transmits the new parameter to attached control 20 effectuating the change. Selecting supplier tab 114 causes user interface 90 to display data regarding a supplier of the asset. Selecting graphic/picture tab 114 causes user interface 90 to display a graphical representation of the asset. Additionally, when the data is numerical such as temperature data, user interface 90 displays the data in a graph format when the user selects a graph tab 116.

[0036] Figure 6 is an alarm history 118 that is displayed when the user selects alarm history tab 108 (also shown in Figure 5). Alarm history 118 includes data regarding an alarm date 120, an alarm cleared date 122, a cleared by column 124, and a alarm description 126. As explained above, alarm date 120 is provided automatically by attached control 20 wirelessly transmitting an alarm to control device 52. Alarm cleared date 122 refers to the date that an alarm was cleared. In one embodiment, alarm cleared date 122 includes the time that an alarm was cleared. Cleared by column 124 lists if an alarm was cleared by attached control 20 or control device 52. Alarm description 126 lists a description of an alarm.

[0037] In one embodiment, control device 52 and attached control 20 include satellite interfaces and control device 52 allows a user to control a plurality of cooling devices 10 at different locations from one location. For example, a company has seventy cooling devices at a plurality of locations and monitors and/or manages the cooling devices from one location. Additionally, some cooling devices are not stationary (such as a refrigerated truck, a refrigerated rail car, and a refrigerated ship container) and control device 52 enables the user to monitor and manage both stationary and non-stationary cooling devices. Additionally, control device 52 estimates times of arrival for non-stationary cooling devices. In an exemplary embodiment, control device is a computer that monitors a plurality of cooling devices in a background such that the user can use the computer for additional tasks such as word processing.

[0038] In an alternative embodiment, control device 52 and attached control 20 include RF interfaces having a range of at least approximately sixty meters. The RF interfaces are less expensive than the satellite interface. A user controls a plurality of cooling

devices 10 at one location. For example, a company has a plurality of cooling devices but not a plurality of locations. Rather, all cooling devices are at the same location. The company may desire to lower costs by utilizing RF interfaces rather than satellites interfaces. Accordingly, the company uses a single control device with a plurality of attached controls at a lower cost with RF interfaces than with satellite interfaces.

[0039] In a further alternative embodiment, control device 52 and attached control 20 include infrared interfaces which are less expensive than the RF interfaces. A user utilizes a hand held infrared device (not shown) to obtain data from a plurality of cooling devices via and then transfers the obtained data to the control device. The user views the data and can change parameters if desired. If the user changes parameters, then the user utilizes the handheld device to transmit that change to the attached control. Accordingly, a user uses a single control device to monitor and control a plurality of attached controls at a lower cost than with RF interfaces.

[0040] While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.